

TABLE 1.—BASIN CHARACTERISTICS OF STATIONS USED IN REGRESSION ANALYSIS.

Station number	Station name	Drainage area A mi ²	Main channel slope S ft/mi	Stream length L mi	Mean basin elevation E ft	Area of lakes and ponds LP % of A	Forest area F % of A	Glacier area G % of A	Annual precipitation P inches	Annual snow-fall Sf inches	January minimum temp. T _j °F.
1523900	Bradley R nr Honer	54.0	191	13.3	2,800	6	7	36	120	200	16
1523900	Fritz C nr Honer	10.4	150	9.8	880	0	7	0	25	70	16
1523980	Thousand C nr Honer	5.35	142	4.7	880	0	37	0	25	70	16
1523990	Anchor R nr Anchor Point	113	45.8	26.2	1,120	0	60	0	25	90	14
1524000	Anchor R at Anchor Point	51.0	29.0	9.70	0	53	0	25	80	80	13
1524050	Cook Inlet R nr Ninilichik	1.69	21.0	3.2	150	0	37	0	20	70	12
1524160	Ninilichik R at Ninilichik	131	12.7	21.0	670	1	95	0	20	70	11
1524200	Kastlor R nr Kastlor	738	68.3	55.0	1,810	15	39	28	50	170	10
1524250	Thousand C nr Priolese	16.8	316	7.4	2,300	0	34	5	70	90	10
1524400	Parmigan C at Lawing	32.6	220	14.6	2,800	6	46	12	90	90	10
1524600	Grant C nr Moose Pass	44.2	150	12.8	2,900	10	20	18	90	90	10
1524800	Trail R nr Lawing	101	89.0	28.0	2,470	2	9	11	90	90	10
1525000	Falls C nr Lawing	11.8	477	8.1	3,480	0	19	6	80	90	10
1525400	Crescent C nr Cooper Landing	31.7	136	14.7	2,700	13	38	0	50	110	8
1525800	Kenai R at Cooper Landing	634	26.8	60.0	2,650	5	13	10	80	140	10
1526000	Cooper C nr Cooper Landing	31.8	194	9.9	2,400	16	44	6	60	110	8
1526050	Stetson C nr Cooper Landing	8.60	459	4.8	3,200	0	47	0	50	110	8
1526400	Russian R nr Cooper Landing	61.8	116	23.5	2,100	4	51	12	70	180	10
1526500	Kenai R at Soldotna	2,010	10.7	110	1,750	5	29	11	60	120	8
1526550	Beaver C nr Kenai	51.0	4.75	13.5	140	15	67	0	20	60	6
1526790	Resurrection C nr Hope	149	126	19.8	2,750	0	28	11	80	160	10
1526800	Granite C nr Portage	28.2	236	9.6	2,220	0	34	0	30	65	6
1527400	Donaldson C nr Hope	4.07	246	11.2	2,760	1	8	0	24	80	10
1527430	NP Campbell C nr Anchorage	13.4	389	10.6	2,670	2	30	0	22	80	6
1527460	NP Campbell C nr Spenard	162	60.7	19.7	1,680	1	46	0	20	70	6
1527480	SR SF Chester C nr Anchorage	10.6	394	6.0	1,340	0	68	0	18	70	6
1527500	Chester C at Anchorage	20.0	226	11.4	1,800	0	61	0	10	70	6
1527510	Chester C at Arctic Blvd at Anchorage	27.2	169	12.8	780	1	59	0	17	70	6
1527600	Ship C nr Anchorage	90.5	119	19.0	3,100	1	13	0	34	80	8
1527710	Eagle R at Eagle River	192	112	33.5	3,120	0	15	13	50	90	8
1527720	Meadow C at Eagle River	7.43	533	7.5	2,900	0	20	0	20	70	7
1528000	Elutina C nr Palmer	265	119	24.5	3,000	7	19	55	80	100	2
1528100	Knik R nr Palmer	1,180	88	43.0	4,000	4	11	54	100	140	6
1528100	Caribou C nr Sutton	289	91.1	39.0	4,100	0	10	0	20	90	2
1528240	Puritan C nr Sutton	8.51	679	3.7	3,000	1	45	0	20	70	0
1528400	Matanuska R at Palmer	2,070	79.7	77.0	4,000	0	14	12	35	80	4
1528600	Cottonwood C nr Wasilla	28.5	44.0	11.4	500	6	85	0	20	55	5
1528600	Little Susitna R nr Palmer	14.9	107	14.9	3,700	5	61	9	50	80	4
1529100	Susitna R nr Denali	950	56.6	51.0	4,510	1	1	25	60	400	-6
1529110	Raft C nr Denali	4.33	617	4.0	4,700	0	12	0	32	350	-8
1529120	Nuclean R nr Paxson	280	133	23.0	4,550	1	0	19	55	400	-4
1529150	Susitna R nr Cartmel	4,140	10.4	10.4	2,500	7	0	19	55	400	-4
1529200	Susitna R at Gold Creek	6,160	10.2	189	3,470	1	7	5	29	200	-5
1529240	Chulitna R nr Talkeetna	2,570	23.0	87.0	3,700	2	22	23	59	250	-5
1529270	Talkeetna R nr Talkeetna	2,007	35.0	90.3	3,400	0	25	7	70	150	-2
1529290	Montana C nr Montana	164	114	25.0	1,930	3	54	0	40	90	0
1529300	Cassell C nr Cassell	19.6	53.8	12.3	400	3	72	0	35	70	0
1529430	Seward R nr Seward	20.8	96.0	20.8	2,100	0	42	0	35	70	-5
1529450	Chakachna R nr Tyonek	1,120	48.8	54.5	3,900	4	17	30	75	400	0

As an example of a calculation of discharge for an ungaged basin, the mean annual discharge for the Susitna River near its mouth is estimated as follows: The three significant independent variables were determined from the appropriate maps as: Drainage area (A) = 19,400 mi²; mean basin elevation (E) = 3,200 ft; mean annual precipitation (P) = 45 in.

$$Q_a = 0.0119 A^{0.99} P^{0.22} E^{0.93}$$

$$Q_a = 0.0119 (19,400)^{0.99} (3,200)^{0.22} (45)^{0.93}$$

$$Q_a = 43,000 \text{ ft}^3/\text{s}$$

In estimating discharge characteristics for ungaged streams in the basin, it is important to use the same methods and maps as were used in the report in deriving the basin characteristics for the ungaged site. It is also important to use values within the range of basin characteristic values used in the regression analysis. Unrealistic values of discharge may result if these guidelines are not followed.

The 38 gaging stations are not evenly distributed throughout the Cook Inlet basin; 26 stations are on the Kenai Peninsula or in the Anchorage area. Therefore, use of the equation in areas such as the west side of Cook Inlet or the nonmountainous areas of the Susitna River basin may also give unrealistic results.

Dividing the mean annual discharge by the drainage area gives the mean annual unit runoff (discharge per square mile). Mean annual precipitation is the dominant factor in determining mean annual unit runoff. In the study area, the largest amounts of precipitation occur in the Kenai, Chugach, and Talkeetna Mountains and the Alaska Range. In the higher elevations of these mountains, annual unit runoff is in excess of 4 (ft³/s)/mi² (cubic feet per second per square mile), and in some areas of the Chugach and Kenai Mountains this value probably exceeds 8 (ft³/s)/mi². The lowest annual unit runoff occurs at the base of the Knik Arm and Mount Susitna where annual unit runoff of less than 0.5 (ft³/s)/mi². The accompanying map shows areal distribution of mean annual unit runoff in the Cook Inlet basin. This map was drawn on the basis of mean annual unit runoff values for the 38 gaging stations and computed values from the mean annual discharge regression equation given above. The contours are highly speculative on the west side of Cook Inlet, on the west side of the Susitna River basin, and in most mountain areas.

ANNUAL DISCHARGE

The annual discharge of streams in the Cook Inlet basin is dependent on many variables, of which the dominant one is the size of the drainage basin. The Susitna River drains slightly more than one-half of the Cook Inlet basin and has the largest mean annual discharge, about 60,000 ft³/s (cubic feet per second). This figure is based on 3 years of record for a station near the mouth and comparison with a long-term station upstream. In deciding order of discharge are other large rivers, the Yentna and Chulitna (both tributaries of the Susitna), the Knik, the Skwentna, and the Kenai.

Variation from year to year in annual discharge is primarily dependent on variation in precipitation. In the Cook Inlet basin the average coefficient of variation (standard deviation divided by mean) for the 38 gaging stations having 5 or more years of record is 0.20. This means that in two-thirds of the years the annual discharge will be within 20 percent of the mean annual discharge; annual discharge rarely varies by more than 50 percent from the mean annual discharge. Glaciers tend to reduce the variation in annual discharge because they release water from ice and firm storage in dry years and store water as snow and ice during wet years. In the Cook Inlet basin there are 10 gaging stations that have more than 15 percent of their drainage area covered by glaciers (table 1). The average coefficient of variation for these stations is 0.14.

An equation to estimate mean annual discharge at ungaged locations was determined by regression analysis using data for gaging stations. The independent variables in the regression analysis were the basin characteristics, which consist of seven physical and three climatic characteristics.

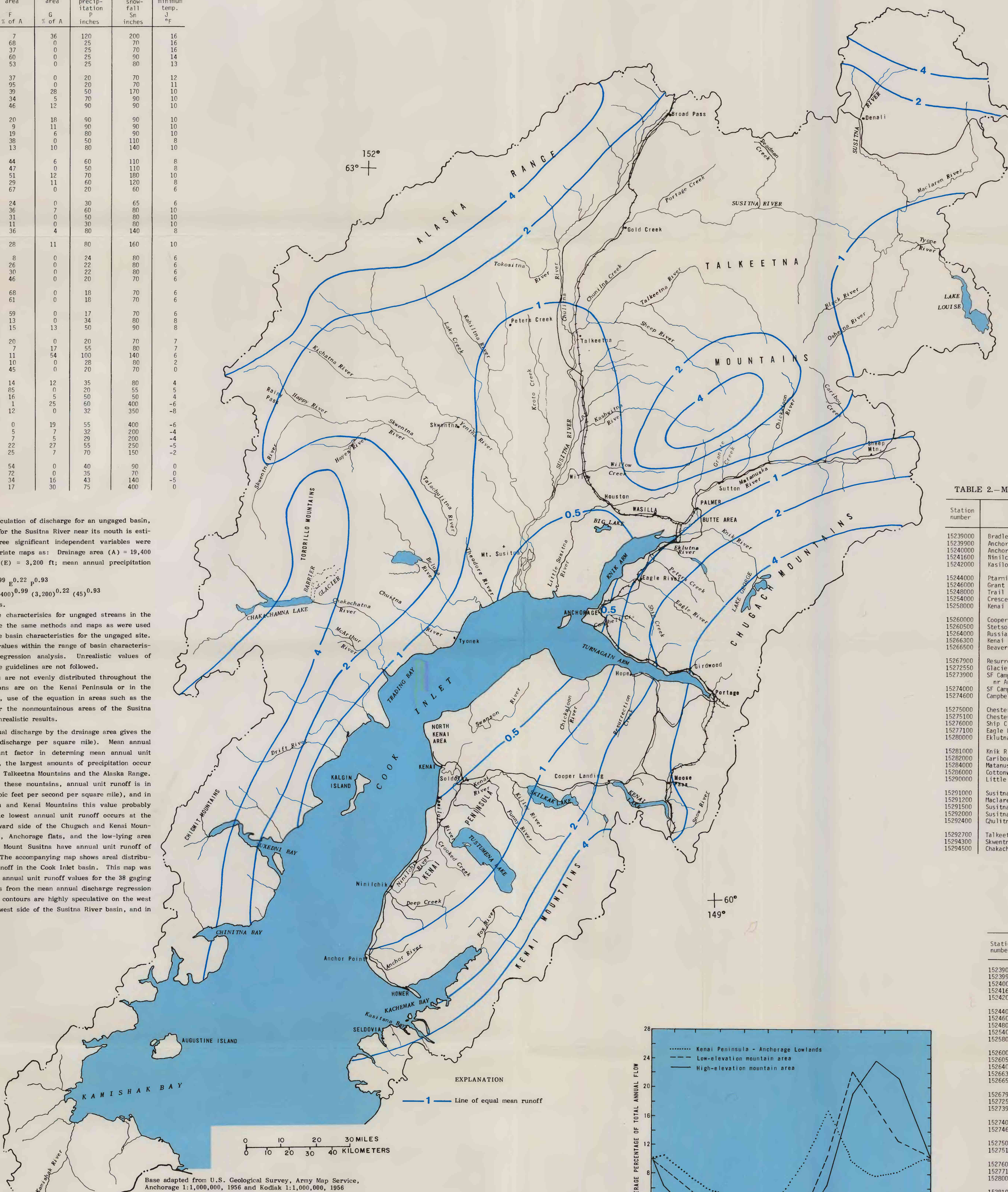
Information about the physical characteristics was obtained from U.S. Geological Survey topographic maps. Drainage area (A), in square miles (mi²), is the total drainage area upstream from the gaging site and is determined by planimetry. Main-channel slope (S), in feet per mile, is the average slope between points 10 percent and 85 percent of the distance along the main stream from the gaging site to the basin divide. Stream length (L), in miles, is the length of the main channel between the gaging site and the basin divide measured along the channel that drains the largest basin. Mean basin elevation (E), in feet above sea level, is the mean elevation of the drainage basin measured by the grid-sampling method. Area of lakes and ponds (LP), in percent, is the percentage of the total drainage area occupied by lakes and ponds and is measured by the grid-sampling method from topographic maps having a blue overprint which indicates lakes and ponds. Area of forests (F), in percent, is the percentage of the total drainage area shown as forested. This is measured by the grid-sampling method from topographic maps having a green overprint which indicates forest cover. Area of glacier (G), in percent, is the percentage of the total drainage area shown as glacier and is measured by the grid-sampling method.

The three climatic characteristics were determined from isohyetal maps using the grid-sampling method. Mean annual precipitation (P), in inches, is the mean annual precipitation at the gaging station. Mean annual snowfall (Sf), in inches, was obtained from National Weather Service publications (National Weather Service, 1972). The mean minimum January temperature (T_j), in degrees Fahrenheit, was calculated from a map by Johnson and Hartman (1969).

Gaging stations with 5 or more years of annual discharge record were selected for use in the regression analysis. Thirty-eight gaging stations in the Cook Inlet basin meet this criterion, and their mean annual discharge are shown in table 2. The basin characteristics for the 38 gaging stations used in the annual discharge regression analysis and for additional stations used in other regression analyses explained in later sections of this report are included in table 1. It was necessary to add the value of 1 to LP, F, and G and the value of 10 to T_j to avoid 0 or negative numbers in using the logarithms of the variables.

Using the standard step-backward regression procedure, only A, F, and E were shown to be significant at the five percent level, and mean annual discharge could be calculated with a standard error of +24 and -20 percent. The relationship $Q_a = 0.0119 A^{0.99} P^{0.22} E^{0.93}$ indicates that the mean annual discharge is almost directly proportional to drainage area. Annual precipitation is a significant factor in determining mean annual discharge, and mean elevation of the basin is a positive, but less significant, factor.

SURFACE WATER



MEAN ANNUAL RUNOFF, IN CUBIC FEET PER SECOND PER SQUARE MILE (Based on annual runoff for 38 gaging stations and regression equation).

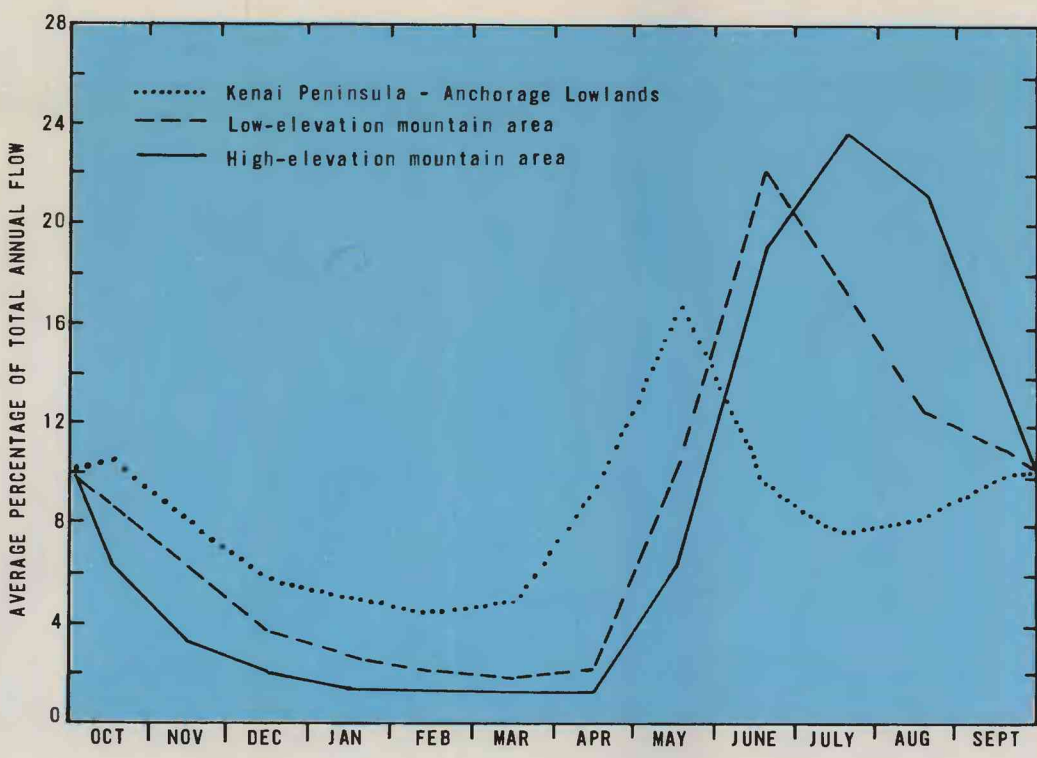


FIGURE 10.—Monthly contribution to total annual streamflow.

MONTHLY DISCHARGE

The seasonal distribution of streamflow reflects the influence of precipitation, air temperature, solar radiation, and natural storage in the drainage basin. Figure 10 shows the seasonal trend for three types of streams in the Cook Inlet basin—the lowland streams, typified by streams on the west side of the Kenai Peninsula and in the Anchorage area; the low-elevation mountain streams which do not flow from glaciers; and the high-elevation mountain streams which usually are fed by glaciers.

Kenai Peninsula - Anchorage Lowlands

Streamflow generally decreases from November through March, with the annual minimum occurring in February or March. During the period from December to March, 20 percent of the annual flow is discharged, with about 4 percent being discharged during the month having minimum flow. The increase in solar radiation in April and May and above-freezing air temperatures result in snowmelt-related peak discharges in April or early May. About 17 percent of the annual discharge occurs during May, the month of maximum flow in this part of the study area. Streamflow decreases during the dry period, June and July; summer low flows are only slightly greater than winter low flows. Streamflow increases in August, September, and October due to rainstorms and decreased evapotranspiration. During the period May through September, 53 percent of the annual flow is discharged.

TABLE 2.—MEAN ANNUAL DISCHARGE (DATA THROUGH 1976 WATER YEAR).

Station number	Station name	Drainage area mi ²	Mean annual discharge					Years of record
			ft ³ /s	(ft ³ /s)/mi ²	inches			
1523900	Bradley R nr Honer	54.0	408	7.56	102.60	19		
1523900	Anchor R nr Anchor Point	113	104	1.38	16.79	8		
1524000	Anchor R at Anchor Point	51.0	299	5.87	71.97	13		
1524160	Ninilichik R at Ninilichik	131	103	0.79	10.68	13		
1524200	Kastlor R nr Kastlor	738	2,885	3.23	43.89	21		
1524400	Parmigan C at Lawing	32.6	111	3.40	46.24	11		
1524600	Grant C nr Moose Pass	44.2	193	4.37	59.30	10		
1524800	Trail R nr Lawing	181	780	4.31	58.22	27		
1525000	Russian R nr Cooper Landing	31.7	824	2.59	32.47	17		
1525800	Kenai R at Cooper Landing	634	2,678	4.22	57.36	29		
1526000	Cooper C nr Cooper Landing	31.8	90.1	2.83	38.48	9		
1526050	Stetson C nr Cooper Landing	8.6	24.8	2.88	39.16	5		
1526400	Russian R nr Cooper Landing	61.8	124	2.01	27.30	11		
1526500	Kenai R at Soldotna	2,010	5,341	2.66	36.08	11		
1526550	Beaver C nr Kenai	51	25.8	0.51	6.87	9		
1526790	Resurrection C nr Hope	149	244	1.64	22.24	9		
1527500	Glacier C at Girdwood	62.0	253	4.08	55.42	11		
1527390	NP Campbell C at canyon mouth nr Anchorage	25.2	38.4	1.52	20.70	10		
1527400	NP Campbell C nr Spenard	162	60.7	0.82	11.16	10		
1527400	Chester C at Anchorage	20.0	18.2	0.91	12.36	18		
1527510	Chester C at Arctic Blvd at Anchorage	27.2	16.3	0.60	8.14	10		
1527600	Ship C nr Anchorage	90.5	157	1.71	23.56	30		
1527710	Eagle R at Eagle River	192	495	2.58	35.01	11		
1528000	Elutina C nr Palmer	110	346	3.15	39.48	8		
1528100	Knik R nr Palmer	1,180	6,761	5.73	77.01	21		
1528100	Caribou C nr Sutton	289	299	1.03	14.05	21		
1528400	Matanuska R at Palmer	2,070	3,051	1.86	25.30	24		
1528600	Cottonwood C nr Wasilla	28.5	25.5	0.89	11.53	5		
1529100	Susitna R nr Denali	61.9	202	3.26	44.32	28		
1529110	Nuclean R nr Paxson	280	2,688	2.83	38.42	17		
1529120	Susitna R nr Cartmel	4,140	2,688	0.65	8.48	18		
1529150	Susitna R at Gold Creek	6,160	6,242	1.01	13.40	10		
1529200	Chulitna R nr Talkeetna	2,570	9,650	3.73	49.40	14		
1529270	Talkeetna R nr Talkeetna	2,007	4,029	2.01	27.27	12		
1529300	Seward R nr Seward	2,250	6,156	2.74	37.16	17		
1529430	Chakachna R nr Tyonek	1,120	3,645	3.25	44.20	13		

TABLE 3.—MEAN MONTHLY DISCHARGE (DATA THROUGH 1976 WATER YEAR).

Station number	Station name	Mean monthly discharge, in ft ³ /s											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
1523900	Bradley R nr Honer	430	177	91.1	64.1	48.6	40.2	43.0	257	743	1,016	1,076	884
1523900	Anchor R nr Anchor Point	239	144	84.3	69.2	74.8	175	577	305	439	429	439	202
1523900	Anchor R nr Anchor Point	351	232	131	93.8	80.2	74.8	148	243	323	342	342	247
1524000	Niitlichik R nr Niitlichik	128	90.0	57.5	50.8	53.7	61.6	148	231	121	83.1	86.3	119
1524000	Kasilof R nr Kasilof	4,001	2,242	1,142	716	569	515	517	664	1,369	3,848	6,628	6,400
1524000	Platinum C at Lawing	113	89.2	42.2	23.5	17.1	14.2	21.9	88.4	247	275	211	170
1524000	Grant R nr Moose Pass	188	110	55.8	30.3	23.2	12.6	10.6	48.8	518	413	307	178
1524800	Cooper C nr Lawing	460	231	147	109	98.8	155	670	1,716	2,081	1,774	1,259	1,059
1524800	Kenal R nr Cooper Landing	76.8	62.7	36.5	17.3	20.7	17.9	24.6	86.3	193	157	107	85
1525800	Kenal R nr Cooper Landing	2,923	1,177	690	694	688	472	1,417	506	1,670	677	1,117	447
1560000	Cooper C nr Cooper Landing	97.6	85.5	39.9	26.9	21.7	17.4	20.1	80.6	214	204	136	122
1560500	Stetson C nr Cooper Landing	21.0	12.5	9.54	8.87	61.0	4.92	5.81	34.3	77.3	52.9	34.1	31.4
1560500	Russian R nr Cooper Landing	16.8	189	95.1	48.7	35.4	30.1	59.7	262	197	116	111	111
1566300	Kenal R nr Kasilof	2,768	1,174	1,517	1,267	1,149	1,186	2,466	7,721	12,616	13,750	11,830	11,443
1566300	Beaver C nr Kenai	34.3	24.1	18.1	15.1	14.5	16.6	35.3	59.1	26.6	19.6	21.3	24.3
1569000	Resurrection C nr Hope	285	161	114	87.6	71.8	68.6	71.1	287	624	536	337	273
1572500	Glacier C at Grindwood	265	117	70.1	40.5	37.8	30.5	57.1	307	603	594	471	435
1573900	SF Campbell C at conyen mouth nr Anchorage	445	28.7	20.5	26.3	13.3	11.1	11.0	33.5	88.5	77.8	58.0	56.9
1574000	SF Campbell C at conyen mouth nr Anchorage	216	14.8	11.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4
1574000	Campbell C nr Sperand	71.7	42.0	29.7	20.3	13.5	13.8	25.1	55.0	12.2	11.3	92.5	88.3
1575000	Chester C at Arctic Blvd at	23.4	17.0	14.3	12.1	10.6	11.0	19.8	22.3	20.1	21.8	24.6	24.6
1575100	Chester C at Arctic Blvd at	21.6	14.8	11.4	10.4	6.70	10.1	18.4	19.9	17.5	19.5	20.5	23.7
1575000	Ship Lnr R at Eagle River	161	92.7	63.5	47.7	38.2	33.0	37.4	164	453	326	241	228
1577100	Eagle R at Eagle River	31	120	83.5	60.7	50.0	40.2	66.3	231	1,651	1,522	822	822
1580000	Kilbuck C nr Palmer	201	142	104	104	104	104	104	104	1,098	980	980	980
1581000	Wilk R nr Palmer	4,142	1,768	852	630	544	463	697	3,184	11,740	24,260	20,630	11,810
1592800	Caribou C nr Sutton	215	54.3	33.1	23.0	18.2	17.6	37.2	56.5	1,241	639	460	333
1598400	Motuska R nr Palmer	1,923	968	709	611	513	446	640	2,741	10,300	12,840	10,160	4,847
1598400	Motuska R nr Palmer	20.5	20.6	17.2	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5
1599000	Little Susitna R nr Palmer	119	57.0	35.9	28.4	22.1	18.2	20.5	194	678	521	440	286
1599100	Susitna R nr Denali	1,161	495	301	237	199	181	226	2,048	7,349	9,352	7,923	3,625
1599100	MacLaren R nr Passon	415	472	113	91.0	79.1	71.8	83.0	2,943	1,532	2,559	1,154	1,154
1599100	MacLaren R nr Passon	3,427	1,441	343	242	242	242	242	2,412	9,000	13,780	9,000	9,000
1599100	Susitna R at Gold Creek	5,660	2,449	1,723	1,420	1,204	1,079	1,340	13,370	28,810	21,810	13,370	13,370
1599400	Chulitna R nr Taiketaa	4,859	1,394	1,457	1,276	1,095	976	1,158	8.51	22,510	26,330	22,190	11,540
1599700	Taichetna R nr Taiketaa	2,666	1,153	814	668	558	491	562	4,115	11,100	10,280	9,261	6,042
1594300	Chulitna R nr Taiketaa	2,666	1,153	814	668	558	491	562	4,115	11,100	10,280	9,261	6,042
1594500	Chulitna R nr Taiketaa	2,468	1,206	813	613	505	441	502	4,141	9,875	11,950	12,620	6,042